



Scientific and Technical
Information Program

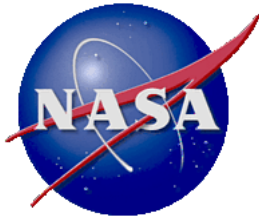


High Bandwidth Communications: 2000-2004

This custom bibliography from the NASA Scientific and Technical Information Program lists a sampling of records found in the NASA Aeronautics and Space Database. The scope of this topic includes optical and high-frequency microwave systems to enhance data transmission rates. This area of focus is one of the enabling technologies as defined by NASA's *Report of the President's Commission on Implementation of United States Space Exploration Policy*, published in June 2004.

Best if viewed with the latest version of Adobe Acrobat Reader





High Bandwidth Communications: 2000-2004

A Custom Bibliography From the
NASA Scientific and Technical Information Program

October 2004

High Bandwidth Communications: 2000-2004

This custom bibliography from the NASA Scientific and Technical Information Program lists a sampling of records found in the NASA Aeronautics and Space Database. The scope of this topic includes optical and high-frequency microwave systems to enhance data transmission rates. This area of focus is one of the enabling technologies as defined by NASA's *Report of the President's Commission on Implementation of United States Space Exploration Policy*, published in June 2004.

OCTOBER 2004

20040084280 Ross-Hime Designs, Inc., Minneapolis, MN, USA

Free Space Optical Communications System Pointer

Rosheim, Mark E.; Sauter, Gerald F.; 37th Aerospace Mechanisms Symposium; May 2004, 171-178; In English; No Copyright; Avail: CASI; [A02](#), Hardcopy

Free Space Optical (FSO) communications pointing problems will be described and a solution presented. Conventional systems used in sea, land, and space are illustrated. Our integrated approach investigates three major problems areas: kinematics, structure, and dexterity. Their interrelationship will be discussed.

Author

Free-Space Optical Communication; Kinematics

20040081420 NASA Goddard Space Flight Center, Greenbelt, MD, USA

Preliminary Results from NASA/GSFC Ka-Band High Rate Demonstration for Near-Earth Communications

Wong, Yen; Gioannini, Bryan; Bundick, Steven N.; Miller, David T.; 2004; In English, 17-21 May 2004, Montreal, Canada; No Copyright; Avail: CASI; [A02](#), Hardcopy

In early 2000, the National Aeronautics and Space Administration (NASA) commenced the Ka-Band Transition Project (KaTP) as another step towards satisfying wideband communication requirements of the space research and earth exploration-satellite services. The KaTP team upgraded the ground segment portion of NASA's Space Network (SN) in order to enable high data rate space science and earth science services communications. The SN ground segment is located at the White Sands Complex (WSC) in New Mexico. NASA conducted the SN ground segment upgrades in conjunction with space segment upgrades implemented via the Tracking and Data Relay Satellite (TDRS)-HIJ project. The three new geostationary data relay satellites developed under the TDRS-HIJ project support the use of the inter-satellite service (ISS) allocation in the 25.25-27.5 GHz band (the 26 GHz band) to receive high speed data from low earth-orbiting customer spacecraft. The TDRS H spacecraft (designated TDRS-8) is currently operational at a 171 degrees west longitude. TDRS I and J spacecraft on-orbit testing has been completed. These spacecraft support 650 MHz-wide Ka-band telemetry links that are referred to as return links. The 650 MHz-wide Ka-band telemetry links have the capability to support data rates up to at least 1.2 Gbps. Therefore, the TDRS-HIJ spacecraft will significantly enhance the existing data rate elements of the NASA Space Network that operate at S-band and Ku-band.

Author (revised)

TDR Satellites; Satellite Communication; Extremely High Frequencies

20040081288 Computer Sciences Corp., USA

Adding HDLC Framing to CCSDS Recommendations

Hogie, Keith; Criscuolo, Ed; Parise, Ron; [2004]; In English, 8-10 Jun. 2004, Hanover, MD, USA

Contract(s)/Grant(s): NASA Order S-43981-G; No Copyright; Avail: Other Sources; Abstract Only

Current Space IP missions use High-Level Data Link Control (HDLC) framing to provide standard serial link interfaces over a space link. HDLC is the standard framing technique used by all routers over clock and data serial lines and is also the basic framing used in all Frame Relay services which are widely deployed in national and international communication networks. In late 2003 a presentation was made to CCSDS committees to initiate discussion on including HDLC in the CCSDS recommendations for space systems. This presentation will summarize the differences between variable length HDLC frames and fixed length CCSDS frames. It will also discuss where and how HDLC framing would fit into the overall CCSDS structures.

Author

Space Communication; Data Links

20040079783 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA, Massachusetts Inst. of Tech., Cambridge, MA, USA, NASA Goddard Space Flight Center, Greenbelt, MD, USA

Architectural Options for a Future Deep Space Optical Communications Network

Edwards, B. L.; Benjamin, T.; Scozzafava, J.; Khatri, F.; Sharma, J.; Parvin, B.; Liebrecht, P. E.; Fitzgerald, R. J.; 2004; In English; SpaceOps 2004 Conference, 17-21 May 2004, Montreal, Canada

Contract(s)/Grant(s): F19628-00-C-0002; Copyright; Avail: CASI; [A02](#), Hardcopy

This paper provides an overview of different options at Earth to provide Deep Space optical communication services. It is based mainly on work done for the Mars Laser Communications Demonstration (MLCD) Project, a joint project between NASA's Goddard Space Flight Center (GSFC), the Jet Propulsion Laboratory, California Institute of Technology (JPL), and the Massachusetts Institute of Technology Lincoln Laboratory (MIT/LL). It also reports preliminary conclusions from the Tracking and Data Relay Satellite System Continuation Study at GSFC. A lasercom flight terminal will be flown on the Mars Telecommunications Orbiter (MTO) to be launched by NASA in 2009, and will be the first high rate deep space demonstration of this revolutionary technology.

Author

Space Communication; Optical Communication; Communication Networks

20040066071 University of South Florida, Tampa, FL, USA

The Case for Deep Space Telecommunications Relay Stations

Chandler, Charles W.; Miranda, Felix A., Technical Monitor; April 2004; In English

Contract(s)/Grant(s): NGT3-52395; WBS-22-322-20-06

Report No.(s): NASA/CR-2004-213053; E-14489; No Copyright; Avail: CASI; [A03](#), Hardcopy

Each future mission to Jupiter and beyond must carry the traditional suite of telecommunications systems for command and control and for mission data transmission to earth. The telecommunications hardware includes the large antenna and the high-power transmitters that enable the communications link. Yet future spacecraft will be scaled down from the hallmark missions of Galileo and Cassini to Jupiter and Saturn, respectively. This implies that a higher percentage of the spacecraft weight and power must be dedicated to telecommunications system. The following analysis quantifies this impact to future missions and then explores the merits of an alternative approach using deep space relay stations for the link back to earth. It will be demonstrated that a telecommunications relay satellite would reduce S/C telecommunications weight and power sufficiently to add one to two more instruments.

Author

Deep Space; Large Space Structures; Relay Satellites; Telecommunication; Space Missions

20040063839

Optical systems for free-space laser communications

Hemmati, H.; Proceedings of SPIE - The International Society for Optical Engineering. Current Developments in Lens Design and Optical Engineering IV; 2003; ISSN 0277-786X; Volume 5173, p. 64-68; In English; Current Developments in Lens Design and Optical Engineering IV, Aug. 3-4, 2003, San Diego, CA, USA; Copyright; Avail: Other Sources

An overview of optical systems utilized in JPL's Optical Communications research is provided here. These include discussions on the flight terminal optics, the ground receiver aperture and the uplink beacon or command optical system. On-going efforts on these and beam-coupling techniques will be described.

EI

Communication Equipment; Optical Communication; Optical Equipment; Receivers; Telescopes

20040040094 NASA Goddard Space Flight Center, Greenbelt, MD, USA

TDRS-1 Going Strong at 20

April 03, 2003; In English; 10 mins., 19 sec. playing time, in color, with sound

Report No.(s): G03-029; No Copyright; Avail: CASI; [V01](#), Videotape-VHS; [B01](#), Videotape-Beta

This video presents an overview of the first Tracking and Data Relay Satellite (TDRS-1) in the form of text, computer animations, footage, and an interview with its program manager. Launched by the Space Shuttle Challenger in 1983, TDRS-1 was the first of a network of satellites used for relaying data to and from scientific spacecraft. Most of this short video is silent, and consists of footage and animation of the deployment of TDRS-1, written and animated explanations of what TDRS satellites do, and samples of the astronomical and Earth science data they transmit. The program manager explains in the final segment of the video the improvement TDRS satellites brought to communication with manned space missions, including

alleviation of blackout during reentry, and also the role TDRS-1 played in providing telemedicine for a breast cancer patient in Antarctica.

CASI

TDR Satellites; Satellite Transmission; Deployment; Satellite Networks; Spacecraft Communication

20040034315

Attenuation mechanism effect on filter shape in channelized dynamic spectral equalizers

Oh, Sang-Hyun; Marom, Dan M.; Applied Optics; January 01, 2004; ISSN 0003-6935; Volume 43, Issue no. 1, 127-131; In English; Copyright

Free-space-based channelized dynamic spectral equalizers are theoretically investigated by solving the temporal-frequency-dependent power-coupling integral for commonly used active device technologies: liquid-crystal modulators, tilting micromirror arrays, and deformable gratings. Channel-filter characteristics, such as bandwidth and interchannel transition, are found to depend on the different attenuation mechanisms provided by the active devices. Such information is required for choosing the proper device parameters in designing channel equalizers and similar free-space spatially dispersed subsystems. [copyright] 2004 Optical Society of America

Author (AIP)

Attitude (Inclination); Bandwidth; Channel Flow; Equalizers (Circuits); Liquid Crystals; Networks; Optical Communication; Optical Fibers; Wavelength Division Multiplexing

20040018608

Analysis of power-dependent phase-matched four-wave mixing in dispersion-managed transmission systems

Gao, Shiming; Yang, Changxi; Jin, Guofan; Applied Optics; December 20, 2003; ISSN 0003-6935; Volume 42, Issue no. 36, 7126-7131; In English; Copyright

We investigate power-dependent phase-matched four-wave mixing (FWM) in wavelength division multiplexing transmission lines, in which positive and negative dispersion fibers are alternately arranged to manage the dispersion and the dispersion slope. The FWM effect shows power-independent phase matching when the channel power is low. However, it is power dependent at high power. The maximum FWM conversion efficiency is shifted away from the zero channel space in the case of power-dependent phase matching. Optimization of the dispersion system for suppression of the FWM effect is determined. [copyright] 2003 Optical Society of America

Author (AIP)

Four-Wave Mixing; Networks; Optical Communication; Optical Fibers; Transmission Lines; Wavelength Division Multiplexing

20040013032 NASA Goddard Space Flight Center, Greenbelt, MD, USA

Orbit Determination Error Analysis Results for the Triana Sun-Earth L2 Libration Point Mission

Marr, G.; [2003]; In English, August 2003, Big Sky, MT, USA; No Copyright; Avail: CASI; [A01](#), Hardcopy

Using the NASA Goddard Space Flight Center's Orbit Determination Error Analysis System (ODEAS), orbit determination error analysis results are presented for all phases of the Triana Sun-Earth L1 libration point mission and for the science data collection phase of a future Sun-Earth L2 libration point mission. The Triana spacecraft was nominally to be released by the Space Shuttle in a low Earth orbit, and this analysis focuses on that scenario. From the release orbit a transfer trajectory insertion (TTI) maneuver performed using a solid stage would increase the velocity by approximately 3.1 km/sec sending Triana on a direct trajectory to its mission orbit. The Triana mission orbit is a Sun-Earth L1 Lissajous orbit with a Sun-Earth-vehicle (SEV) angle between 4.0 and 15.0 degrees, which would be achieved after a Lissajous orbit insertion (LOI) maneuver at approximately launch plus 6 months. Because Triana was to be launched by the Space Shuttle, TTI could potentially occur over a 16 orbit range from low Earth orbit. This analysis was performed assuming TTI was performed from a low Earth orbit with an inclination of 28.5 degrees and assuming support from a combination of three Deep Space Network (DSN) stations, Goldstone, Canberra, and Madrid and four commercial Universal Space Network (USN) stations, Alaska, Hawaii, Perth, and Santiago. These ground stations would provide coherent two-way range and range rate tracking data usable for orbit determination. Larger range and range rate errors were assumed for the USN stations. Nominally, DSN support would end at TTI+144 hours assuming there were no USN problems. Post-TTI coverage for a range of TTI longitudes for a given nominal trajectory case were analyzed. The orbit determination error analysis after the first correction maneuver would be

generally applicable to any libration point mission utilizing a direct trajectory.

Author

Error Analysis; Orbit Determination; Range and Range Rate Tracking; Low Earth Orbits

20040011210

Simple technique to widen the passband of a free-space optics multiplexer and demultiplexer

Chassagne, Bruno; Ravelomanana, Vlady; Journal of the Optical Society of America B: Optical Physics; November 2003; ISSN 0740-3224; Volume 20, Issue no. 11, 2270-2273; In English; Copyright

We report on a simple method to flatten the optical spectral response of a conventional Gaussian-like transfer function multiplexer and demultiplexer. Advantages and drawbacks of the technique are discussed, and an analytical formula that permits easy optical design is given. [copyright] 2003 Optical Society of America

Author (AIP)

Communication Equipment; Demultiplexing; Multiplexing; Optical Communication; Optical Transfer Function; Optical Waveguides; Transfer Functions; Waveguide Filters; Wavelength Division Multiplexing

20040006806

High-speed two-dimensional laser scanner based on Bragg gratings stored in photothermorefractive glass

Yaqoob, Zahid; Arain, Muzammil A.; Riza, Nabeel A.; Applied Optics; September 10, 2003; ISSN 0003-6935; Volume 42, Issue no. 26, 5251-5262; In English; Copyright

A high-speed free-space wavelength-multiplexed optical scanner with high-speed wavelength selection coupled with narrowband volume Bragg gratings stored in photothermorefractive (PTR) glass is reported. The proposed scanner with no moving parts has a modular design with a wide angular scan range, accurate beam pointing, low scanner insertion loss, and two-dimensional beam scan capabilities. We present a complete analysis and design procedure for storing multiple tilted Bragg-grating structures in a single PTR glass volume (for normal incidence) in an optimal fashion. Because the scanner design is modular, many PTR glass volumes (each having multiple tilted Bragg-grating structures) can be stacked together, providing an efficient throughput with operations in both the visible and the infrared (IR) regions. A proof-of-concept experimental study is conducted with four Bragg gratings in independent PTR glass plates, and both visible and IR region scanner operations are demonstrated. [copyright] 2003 Optical Society of America

Author (AIP)

Bragg Gratings; High Speed; Infrared Spectra; Laser Applications; Multiplexing; Optical Communication; Optical Scanners; Scanners; Visible Spectrum; Wave Diffraction

20040003743 NASA Glenn Research Center, Cleveland, OH, USA

Three-Dimensional Simulation of Traveling-Wave Tube Cold-Test Characteristics Using CST MICROWAVE STUDIO

Chevalier, Christine T.; Herrmann, Kimberly A.; Kory, Carol L.; Wilson, Jeffrey D.; Cross, Andrew W.; Santana, Samuel; July 2003; In English

Contract(s)/Grant(s): WBS 22-755-12-30

Report No.(s): NASA/TM-2003-212486; NAS 1.15:212486; E-14028; No Copyright; Avail: CASI; [A03](#), Hardcopy

The electromagnetic field simulation software package CST MICROWAVE STUDIO (MWS) was used to compute the cold-test parameters - frequency-phase dispersion, on-axis impedance, and attenuation - for a traveling-wave tube (TWT) slow-wave circuit. The results were compared to experimental data, as well as to results from MAFIA, another three-dimensional simulation code from CST currently used at the NASA Glenn Research Center (GRC). The strong agreement between cold-test parameters simulated with MWS and those measured experimentally demonstrates the potential of this code to reduce the time and cost of TWT development.

Author

Three Dimensional Models; Wave Propagation; Computerized Simulation

20030105557 NASA Goddard Space Flight Center, Greenbelt, MD, USA

Near Earth Architectural Options for a Future Deep Space Optical Communications Network

Edwards, B. L.; Liebrecht, P. E.; Fitzgerald, R. J.; [2003]; In English, Montreal, Canada; No Copyright; Avail: Other Sources; Abstract Only

In the near future the National Aeronautics and Space Administration anticipates a significant increase in demand for long-haul communications services from deep space to Earth. Distances will range from 0.1 to 40 AU, with data rate

requirements in the 1's to 1000's of Mbits/second. The near term demand is driven by NASA's Space Science Enterprise which wishes to deploy more capable instruments onboard spacecraft and increase the number of deep space missions. The long term demand is driven by missions with extreme communications challenges such as very high data rates from the outer planets, supporting sub-surface exploration, or supporting NASA's Human Exploration and Development of Space Enterprise beyond Earth orbit. Laser communications is a revolutionary communications technology that will dramatically increase NASA's ability to transmit information across the solar system. Lasercom sends information using beams of light and optical elements, such as telescopes and optical amplifiers, rather than RF signals, amplifiers, and antennas. This paper provides an overview of different network options at Earth to meet NASA's deep space lasercom requirements. It is based mainly on work done for the Mars Laser Communications Demonstration Project, a joint project between NASA's Goddard Space Flight Center (GSFC), the Jet Propulsion Laboratory, California Institute of Technology (JPL), and the Massachusetts Institute of Technology Lincoln Laboratory (MIT/LL). It reports preliminary conclusions from the Mars Lasercom Study conducted at MIT/LL and on additional work done for the Tracking and Data Relay Satellite System Continuation Study at GSFC. A lasercom flight terminal will be flown on the Mars Telesat Orbiter (MTO) to be launched by NASA in 2009, and will be the first high rate deep space demonstration of this revolutionary technology.

Author

Spacecraft Communication; Optical Communication; Interplanetary Spacecraft; Communication Networks; Architecture (Computers)

20030105555 NASA Goddard Space Flight Center, Greenbelt, MD, USA

Overview of the MARS Laser Communications Demonstration Project

Edward, Bernard L.; Townes, Stephen A.; Bondurant, Roy S.; Scozzafava, Joseph J.; Boroson, Don M.; Parvin, Ben A.; Biswas, Abhijit; Pillsbury, Alan D.; Khatri, Farzana I.; Burnside, Jamie W., et al.; [2003]; In English, 23-25 Sep. 2003, USA; No Copyright; Avail: CASI; [A02](#), Hardcopy

This paper provides an overview of the Mars Laser Communications Demonstration Project, a joint project between NASA's Goddard Space Flight Center (GSFC), the Jet Propulsion Laboratory, California Institute of Technology (JPL), and the Massachusetts Institute of Technology Lincoln Laboratory (MIT/LL). It reviews the strawman designs for the flight and ground segments, the critical technologies required, and the concept of operations. It reports preliminary conclusions from the Mars Lasercom Study conducted at MIT/LL and on additional work done at JPL and GSFC. The lasercom flight terminal will be flown on the Mars Telecom Orbiter (MTO) to be launched by NASA in 2009, and will demonstrate a technology which has the potential of vastly improving NASA's ability to communicate throughout the solar system.

Author

Optical Communication; Solar System

20030093732 NASA Glenn Research Center, Cleveland, OH, USA

Beam-Switch Transient Effects in the RF Path of the ICAPA Receive Phased Array Antenna

Sands, O. Scott; September 2003; In English

Contract(s)/Grant(s): WBS 22-322-70-01

Report No.(s): NASA/TM-2003-212588; E-14145; NAS 1.15:212588; No Copyright; Avail: CASI; [A03](#), Hardcopy

When the beam of a Phased Array Antenna (PAA) is switched from one pointing direction to another, transient effects in the RF path of the antenna are observed. Testing described in the report has revealed implementation-specific transient effects in the RF channel that are associated with digital clocking pulses that occur with transfer of data from the Beam Steering Controller (BSC) to the digital electronics of the PAA under test. The testing described here provides an initial assessment of the beam-switch phenomena by digitally acquiring time series of the RF communications channel, under CW excitation, during the period of time that the beam switch transient occurs. Effects are analyzed using time-frequency distributions and instantaneous frequency estimation techniques. The results of tests conducted with CW excitation supports further Bit-Error-Rate (BER) testing of the PAA communication channel.

Author

Beam Switching; Phased Arrays; Antenna Arrays

20030057555

Analysis of light propagation in index-tunable photonic crystals

Xiong, Sibe; Fukushima, Hiroshi; Journal of Applied Physics; July 15, 2003; ISSN 0021-8979; Volume 94, Issue no. 2, 1286-1288; In English; Copyright

Propagation behaviors of light in index-tunable photonic crystals were analyzed by calculating the directions of the group velocity of light in the photonic crystals. Simulation results reveal that the band structures of tunable photonic crystals are highly anisotropic and the equifrequency surface curves in the wave-vector space of photonic crystals can show acute variation corresponding to an index change when operation frequency and incident angle are carefully selected. In the case of a triangular system composed of ferroelectric background and circular airholes, 'on/off' switching can be operated when operation frequency $a/[\lambda]$ is 0.4205 and the incident angle falls into a window of 32[deg]-49[deg]. Light can deflect 40[deg] when the operation frequency $a/[\lambda]$ and incident angle are 0.5372 and 23[deg], respectively. Two types of optical switches based on the anisotropic characteristics of index-tunable photonic crystals are proposed, which will find great potential applications in optical communications. [copyright] 2003 American Institute of Physics.

Author (AIP)

Ferroelectric Materials; Group Velocity; Light Transmission; Refractivity; Switches; Tuning

20030055187

Design and implementation of a modulator-based free-space optical backplane for multiprocessor applications

Kirk, Andrew G.; Plant, David V.; Szymanski, Ted H.; Vranesic, Zvonko G.; Tooley, Frank A. P.; Rolston, David R.; Ayliffe, Michael H.; Lacroix, Frederic K.; Robertson, Brian; Bernier, Eric; Applied Optics; May 10, 2003; ISSN 0003-6935; Volume 42, Issue no. 14, 2465-2481; In English; Copyright

Design and implementation of a free-space optical backplane for multiprocessor applications is presented. The system is designed to interconnect four multiprocessor nodes that communicate by using multiplexed 32-bit packets. Each multiprocessor node is electrically connected to an optoelectronic VLSI chip which implements the hyperplane interconnection architecture. The chips each contain 256 optical transmitters (implemented as dual-rail multiple quantum-well modulators) and 256 optical receivers. A rigid free-space microoptical interconnection system that interconnects the transceiver chips in a 512-channel unidirectional ring is implemented. Full design, implementation, and operational details are provided. [copyright] 2003 Optical Society of America

Author (AIP)

Circuit Boards; Gratings (Spectra); Light Modulation; Multiprocessing (Computers); Optical Communication; Optical Computers; Optical Data Processing; Optical Interconnects

20030048214

Spatial phase information transmission through an optical fiber by coherence function synthesis

Teramura, Yuichi; Kannari, Fumihiko; Applied Optics; December 10, 2001; ISSN 0003-6935; Volume 40, Issue no. 35, 6466-6473; In English; Copyright

Transmission of one-dimensional spatial phase information by low-coherence light through a single-mode optical fiber is experimentally demonstrated by use of space-time conversion at a 4-f Fourier coherence function shaper and time-space conversion with spectral holography. The dispersion during the fiber propagation can be automatically compensated for with spectral holography. However, space-time coupling caused by the transmitter limits the capacity of information transmittable with one coherence function shaping. A significant advantage in the space-time-space conversion with low-coherence light is that an infinite number of signal channels can be multiplexed with a newly invented delay-time division scheme, which can extend this analog transmission to two-dimensional spatial phase patterns. [copyright] 2001 Optical Society of America

Author (AIP)

Data Transmission; Fiber Optics; Fourier Transformation; Holography; Light Transmission; Optical Communication; Optical Fibers; Phase Coherence; Space-Time Functions; Time Division Multiplexing

20030040240

Optimum divergence angle of a Gaussian beam wave in the presence of random jitter in free-space laser communication systems

Toyoshima, Morio; Jono, Takashi; Nakagawa, Keizo; Yamamoto, Akio; Journal of the Optical Society of America A: Optics, Image Science, and Vision; March 2002; ISSN 0740-3232; Volume 19, Issue no. 3, 567-571; In English; Copyright

The average bit error rate (BER) of optical communication systems is considered in the presence of random angular jitter.

First, the received power and the BER in the absence of jitter are reviewed. Then the average BER is obtained in the presence of circularly symmetric, normally distributed jitter by using the probability density function of the optical signal. By minimizing the power penalty for average BER, the optimum ratio of the divergence angle of the laser beam to the random angular jitter at the desired BER is obtained. An analytic approximation of the optimum ratio is derived as a function of the desired average BER. The results can be used for designing the link budget of optical communication and tracking channels in the presence of jitter. [copyright] 2002 Optical Society of America

Author (AIP)

Bit Error Rate; Channels (Data Transmission); Communication Satellites; Data Links; Optical Communication; Optimization; Telecommunication; Vibration

20030020749 NASA Glenn Research Center, Cleveland, OH, USA

Continuous Beam Steering From A Segmented Liquid Crystal Optical Phased Array

Pouch, John; Nguyen, Hung; Miranda, Felix; Titus, Charles M.; Bos, Philip J.; November 25, 2002; In English

Contract(s)/Grant(s): NAG3-2539; No Copyright; Avail: CASI; [A03](#), Hardcopy

Optical communications to and from deep space probes will require beams possessing divergence on the order of a microradian, and must be steered with sub-microradian precision. Segmented liquid crystal spatial phase modulators, a type of optical phased array, are considered for this ultra-high resolution beam steering. It is shown here that in an ideal device of this type, there are ultimately no restrictions on the angular resolution. Computer simulations are used to obtain that result, and to analyze the influence of beam truncation and substrate flatness on the performance of this type of device.

Author

Beam Steering; Liquid Crystals; Optical Communication; Phased Arrays; Computerized Simulation; Continuous Radiation

20030002493 Florida Inst. of Tech., FL USA

Space-Based Encoded Telemetry for Range Safety

Kozaitis, Samuel P.; 2000 Final Administrative Report NASA/ASEE Summer Faculty Fellowship Program; June 2002; In English

Contract(s)/Grant(s): NAG10-280; No Copyright; Avail: Other Sources; Abstract Only

This work involves the analysis of a communication system that uses the NASA Tracking and Data Relay Satellite/space Network (TDRSS/SN) to provide range safety and flight termination system support for expendable launch vehicles and the space shuttle. We examined the high-alphabet scheme for flight termination, and considered an analogous digital system. We also considered the bit-rate needed for a flight termination system using the TDRSS system based on the received signal-to-noise ratio, and link margin. We found that a TDRSS spread-spectrum communication system operating in the vicinity of 150 bits/second could satisfy the requirements for flight termination.

Author

Telemetry; Safety Management; Signal to Noise Ratios; Satellite Networks; Range Safety; Telecommunication

20030001567 NASA Marshall Space Flight Center, Huntsville, AL USA

High-Rate Communications Outage Recorder Operations for Optimal Payload and Science Telemetry Management Onboard the International Space Station

Shell, Michael T.; McElyea, Richard M., Technical Monitor; [2002]; In English; Space Ops 2002, 9-12 Oct. 2002, Houston, TX, USA; No Copyright; Avail: Other Sources; Abstract Only

All International Space Station (ISS) Ku-band telemetry transmits through the High-Rate Communications Outage Recorder (HCOR). The HCOR provides the recording and playback capability for all payload, science, and International Partner data streams transmitting through NASA's Ku-band antenna system. The HCOR is a solid-state memory recorder that provides recording capability to record all eight ISS high-rate data during ISS Loss-of-Signal periods. NASA payloads in the Destiny module are prime users of the HCOR; however, NASDA and ESA will also utilize the HCOR for data capture and playback of their high data rate links from the Kibo and Columbus modules. Marshall Space Flight Center's Payload Operations Integration Center manages the HCOR for nominal functions, including system configurations and playback operations. The purpose of this paper is to present the nominal operations plan for the HCOR and the plans for handling contingency operations affecting payload operations. In addition, the paper will address HCOR operation limitations and the expected effects on payload operations. The HCOR is manifested for ISS delivery on flight 9A with the HCOR backup

manifested on flight 11A. The HCOR replaces the Medium-Rate Communications Outage Recorder (MCOR), which has supported payloads since flight 5A.1.

Author

Flight Operations; International Space Station; Payload Integration; Systems Engineering; Recording Instruments; Radio Telemetry

20020081299 NASA Glenn Research Center, Cleveland, OH USA

Variable Delay Testing Using ONE

Ishac, Joseph; August 2002; In English

Contract(s)/Grant(s): RTOP 258-90-00

Report No.(s): NASA/TM-2002-211802; E-13497; NAS 1.15:211802; No Copyright; Avail: CASI; [A03](#), Hardcopy

This paper investigates the effect of long and changing propagation delays on the performance of TCP file transfers. Tests are performed with machines that emulate communication from a low/medium-earth satellite to Earth by way of a geosynchronous satellite. As a result of these tests, we find that TCP is fairly robust to varying delays given a high enough TCP timer granularity. However, performance degrades noticeably for larger file transfers when a finer timer granularity is used. Such results have also been observed in previous simulations by other researchers, and thus, this work serves as an extension of those results.

Author

Satellite Communication; Orbits; Data Transmission; Networks

20020081112 NASA Glenn Research Center, Cleveland, OH USA

Implementation of a 622 Mbps Digital Modem

Kifle, Muli; Bizon, Thomas P.; Nguyen, Nam T.; Tran, Quang K.; Mortensen, Dale J.; July 2002; In English, 12-15 May 2002, Montreal, Quebec, Canada; Original contains color illustrations

Contract(s)/Grant(s): RTOP 755-08-0B

Report No.(s): NASA/TM-2002-211680; E-13409; NAS 1.15:211680; No Copyright; Avail: CASI; [A03](#), Hardcopy

This paper presents the implementation and initial test results of an Orthogonal Frequency Division Multiplexing (OFDM) digital modem (modulator and demodulator) with an aggregate information throughput of 622 megabits per second (Mbps). The OFDM waveform is constructed by dividing an incoming data stream into four channels, each channel using either a 16-ary Quadrature Amplitude Modulation (16QAM) scheme or an 8-Phase Shift Keying (8PSK) scheme. The generation and detection of the composite waveform are performed using Discrete Fourier Transform (DFT) and polyphase filtering, to digitally stack and band-limit the individual carriers respectively. The four-channel OFDM approach enables the implementation of a modem that can be both power and bandwidth efficient, with sufficient parallelism to meet higher data rate goals. As a result, the OFDM modem requires only a 240 MHz bandwidth to transmit 622 Mbps. Hardware and simulation results in the form of spectrum diagrams and bit-error-rate (BER) curves are also presented in this paper.

Author

Space Communication; Modems; Frequency Division Multiplexing; Data Flow Analysis; Component Reliability

20020063747

Regular and chaotic dynamics of periodically amplified picosecond solitons

Kominis, Yannis; Hizanidis, Kyriakos; Journal of the Optical Society of America B: Optical Physics; August 2002; ISSN 0740-3224; Volume 19, Issue no. 8, 1746-1758; In English; Copyright

Chirped-pulse propagation under periodic amplification is considered on the basis of the variational method, and the resulting pulse-shape chaotic oscillations are studied. The system of equations governing the evolution of the parameter functions is nonintegrable and is solved by the canonical perturbation method and the construction of local approximate invariants embracing all the essential features of the phase-space dynamics. The latter provide useful guidelines for choosing the appropriate launching-pulse width and chirp for stable propagation for each specific transmission-link configuration. This fact is supported by comparison of the analytic results with the respective numerical ones of the exact dynamical system obtained by the variational method and by the direct integration of the nonlinear Schrodinger equation as well. The structure of the chaotic layer between the two distinct modes of behavior of a propagating pulse, namely, breathing and spreading/decaying, is also investigated qualitatively by utilizing Melnikov's method. Examples from technologically realistic

configurations are given for 4-14-ps pulses and for amplification periods of 40-100 km. [copyright] 2002 Optical Society of America

Author (AIP)

Approximation; Chaos; Chirp; Fiber Optics; Light Modulation; Modulation; Nonlinear Optics; Optical Communication; Optical Fibers; Perturbation Theory; Scattering; Schroedinger Equation; Solitary Waves

20020059644 Swedish Defence Research Establishment, Linköping, Sweden

Overview of Laser Activities at FOI Linköping, Sweden

Steinvall, O.; Sep. 2001; In English

Report No.(s): PB2002-104452; FOI-R-0199-SE; No Copyright; Avail: CASI; [A03](#), Hardcopy

This overview gives a brief historical overview of the Department of Laser Systems at FOI, along with a more detailed description of the recent research. The activities within the Laser Department are organized in four research areas: Lasers for remote sensing, Distributed laser sensor networks, Photonics and optical components, and Modeling and simulation. Recent activities in our research include field studies of fiber hydrophones, test of an electronic nose in Kosovo, field tests of range gated viewing for target recognition, development of a compact multifunctional coherent laser radar, demonstration of an antisensor laser system (LYSA), development of a computer based laser radar model, field trial and data analysis of airborne and ground based laser scanning for synthetic environments and 3-D (three dimensional) laser radar cross-section measurements. We are also studying laser warning devices and their role in the Defensive Aids Suite for different platforms. Free space laser communications is another area in which we are active, both in performance testing of commercial links and in development of new concepts.

NTIS

Lasers; Remote Sensing; Photonics; Laser Applications; Simulation

20010110021 Florida Inst. of Tech., Melbourne, FL USA

Space-based Encoded Telemetry for Range Safety

Kozaitis, Sam; 2000 Research Reports: NASA/ASEE Summer Faculty Fellowship Program; October 2001, 131-140; In English; No Copyright; Avail: CASI; [A02](#), Hardcopy

This work involves the analysis of a communication system that uses the NASA Tracking and Data Relay Satellite/Space Network (TDRSS/SN) to provide range safety and flight termination system support for expendable launch vehicles and the space shuttle. We examined the high-alphabet scheme for flight termination, and considered an analogous digital system. We also considered the bit-rate needed for a flight termination system using the TDRSS system based on the received signal-to-noise ratio, and link margin. We found that a TDRSS spread-spectrum communication system operating in the vicinity of 150 bits/second could satisfy the requirements for flight termination.

Author

Telemetry; Launch Vehicles; Space Shuttles; Digital Systems; Range Safety; Abort Apparatus; Spread Spectrum Transmission

20010092692 New Mexico State Univ., Las Cruces, NM USA

First Experimental Demonstration of Full-Duplex Optical Communication on a Single Beam

Garrett, Christopher David; Shay, Thomas; May 2001; In English

Contract(s)/Grant(s): NAG5-9323

Report No.(s): NMSU-ECE-01-009; No Copyright; Avail: CASI; [A04](#), Hardcopy

The satellite industry is driven by the need to reduce costs. One way they have sought to do this is by reducing the size and weight of the satellite because of the extremely high cost per kilogram incurred launching a payload into orbit. The main difficulty in this approach is the lack of power capacity in a small satellite. One of the largest loads on a satellite's power system is the communications system. This has driven the need for a low-power communications system. This document examines a novel method of communicating optically with a low-Earth-orbit satellite from the ground without the need for a laser on the payload. The goal is to show the feasibility of such a system as a solution to the small satellite low-powered communication problem. Specially, that the system described herein: is capable of ground to low-Earth-orbit communications, has very little space-borne mass, and draws little power from the satellite. First, the system (hereafter referred to as LOWCAL 'Lightweight Optical Wavelength Communication without A Laser in space') will be explained with details of the formats used and the link budgets. Discussions will be presented on the development of some of the system hardware (the laser diode driver, liquid crystal driver, and decision electronics for both the up and down links.) Finally, experimental test results of the entire system operating in a laboratory environment are presented and compared to theory. The results of the laboratory experiment

support the original thesis: retro-modulated optical communications can meet the needs of the small satellite community. The system is capable of 10-kbps communication, has low space-borne mass, and draws little power from the satellite (less than 100-mW measured for the laboratory experiment, less than 1.5-W calculated for the Shuttle experiment).

Author

Optical Communication; Beams (Radiation); Downlinking; Lasers

20010092461 Naval Air Warfare Center, Patuxent River, MD USA

Standard Message Definition - Statement of Need

Jones, Sid; May 10, 2001; In English

Report No.(s): AD-A392027; No Copyright; Avail: CASI; [A02](#), Hardcopy

There are many standards available to the telemetry community for internetworking systems together. The vast majority of these standards apply to the movement of data. A standard is needed to define the data itself. However, the format of the data being moved is closely tied to the applications that source and sink the data. This project will focus on defining a structure(s) for the various messages required within a data acquisition network.

DTIC

Data Acquisition; Messages; Computer Networks

20010092186 New Mexico State Univ., Las Cruces, NM USA

LOWCAL Ground Receiver: PMT Characterization Procedure and Results

MacCannell, John, Alexander; Jun. 06, 2001; In English

Contract(s)/Grant(s): NAG5-9323

Report No.(s): NMSU-ECE-01-006; No Copyright; Avail: CASI; [A03](#), Hardcopy

This paper is part of a series of papers for a research project at New Mexico State University. The project is referred to as LOWCAL or Lightweight optical wavelength communications without a laser in space. While some of the material presented is specific to the LOWCAL project, the general procedure for characterization and calibration of a photomultiplier tube is presented.

Author

Optical Communication; Calibrating; Low Noise

20010076859 National Space Development Agency, Tsukuba, Japan

Optical-Fiber Amplifier Research

Araki, Tomohiro; Proceedings of Advanced Space Technology Workshop; September 2000, 129-136; In English; Also available within the Conference Proceedings with 4 other reports on CD-ROM. See 20010068892.; Copyright; Avail: CASI; [A02](#), Hardcopy; US Distribution and Sales Only

Research into optical-fiber amplifiers is presented. The main objectives of the research subject is optical communications between satellites. Optical inter-satellite communications are wireless optical communications between satellites. With the onset of the 21st century, there is a need for data relay systems using stationary satellites to provide support for various future space activities including global monitoring and space station manned activities.

Derived from text

Optical Communication; Satellite Communication; Light Amplifiers

20010068460 NASA Goddard Space Flight Center, Greenbelt, MD USA

Infrared Communications for Small Spacecraft: From a Wireless Bus to Cluster Concepts

Webb, Suzanne C.; Schneider, Wolfger; Darrin, M. Ann G.; Boone, Bradley G.; Luers, Philip J.; Day, John H., Technical Monitor; [2001]; In English; Original contains color illustrations

Contract(s)/Grant(s): NAG5-10464; No Copyright; Avail: CASI; [A03](#), Hardcopy

Nanosatellites operating singly or in clusters are anticipated for future space science missions. To implement this new communications paradigm, we are approaching cluster communications by first developing an infrared (IR) intra-craft wireless bus capability, following initially the MIL-STD-1553B protocol. Benefits of an IR wireless bus are low mass, size, power, and cost, simplicity of implementation, ease of use, minimum EMI, and efficient and reliable data transfer. Our goals are to maximize the reliable link margin in order to afford greater flexibility in receiver placement, which will ease technology insertion. We have developed a concept demonstration using a high-speed visible-band silicon PIN photodiode and a high-efficiency visible LED operating at a data rate up to 4 Mb/sec. In designing an internal IR wireless bus, we have

characterized various candidate materials, emitters, and geometries, assuming a single reflection. Thus, we have measured the bidirectional reflectance distribution function (BRDF) for five different materials characteristic of typical spacecraft structures, which range from nearly Lambertian to highly specular. We have fit our data to empirical BRDF functions and modeled the detected irradiance anywhere in the plane of incidence for a divergent (LED) emitter. We have also determined the angular limits on the link geometry to remain within the required bit error rate by determining the received signal-to-noise ratio (SNR) for minimum values of irradiance received at the detector.

Author

Infrared Radiation; Optical Communication; Spacecraft Structures; Emitters

20010047408 NASA Glenn Research Center, Cleveland, OH USA

ATM QoS Experiments Using TCP Applications: Performance of TCP/IP Over ATM in a Variety of Errored Links

Frantz, Brian D.; Ivancic, William D.; January 2001; In English

Contract(s)/Grant(s): RTOP 322-20-2A

Report No.(s): NASA/TM-2001-209644; E-11990; NAS 1.15:209644; No Copyright; Avail: CASI; [A03](#), Hardcopy

Asynchronous Transfer Mode (ATM) Quality of Service (QoS) experiments using the Transmission Control Protocol/Internet Protocol (TCP/IP) were performed for various link delays. The link delay was set to emulate a Wide Area Network (WAN) and a Satellite Link. The purpose of these experiments was to evaluate the ATM QoS requirements for applications that utilize advance TCP/IP protocols implemented with large windows and Selective ACKnowledgements (SACK). The effects of cell error, cell loss, and random bit errors on throughput were reported. The detailed test plan and test results are presented herein.

Author

Asynchronous Transfer Mode; Quality Control; Protocol (Computers); Wide Area Networks

20010018822 Naval Air Warfare Center, Patuxent River, MD USA

Telemetry Networks

Jones, Sid; Jan. 2000; In English

Report No.(s): AD-A383976; No Copyright; Avail: CASI; [A02](#), Hardcopy

Contents of this document include Data Acquisition Networks T&E Need, Network Centric Testing, Traditional Systems, On-Board Data Acquisition Networks, Ground-Based Networks, Traditional Systems, Packetized Telemetry, Data Acquisition Networks, Telemetry Networks, An Integrated Path to T & E Networks, Other DoD efforts, 'Close Encounters' Analogy, and Summary.

DTIC

Telemetry; Data Transmission

20000093959 Aerojet-General Corp., Azusa, CA USA

Integrated AMSU-A. Earth Observing System (EOS), Advanced Microwave Sounding Unit-A (AMSU-A): Engineering Telemetry Description

Calderon, M.; August 2000; In English

Contract(s)/Grant(s): NAS5-32314

Report No.(s): AEROJET-10377C; CDRL-305; No Copyright; Avail: CASI; [A03](#), Hardcopy

This is the Engineering Telemetry Description, for the Integrated Advanced Microwave Sounding Unit-A (AMSU-A).

Author

Advanced Microwave Sounding Unit; Earth Observing System (EOS); Microwave Sounding; Telemetry

20000075272 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA USA

The NASA Spacecraft Transponding Modem

Berner, Jeff B.; Kayalar, Selahattin; Perret, Jonathan D.; [2000]; In English; No Copyright; Avail: Other Sources; Abstract Only

A new deep space transponder is being developed by the Jet Propulsion Laboratory for NASA. The Spacecraft Transponding Modem (STM) implements the standard transponder functions and the channel service functions that have previously resided in spacecraft Command/Data Subsystems. The STM uses custom ASICs, MMICs, and MCMs to reduce the active device parts count to 70, mass to 1 kg, and volume to 524 cc. The first STMs will be flown on missions launching in the 2003 time frame. The STM tracks an X-band uplink signal and provides both X-band and Ka-band downlinks, either

coherent or non-coherent with the uplink. A NASA standard Command Detector Unit is integrated into the STM, along with a codeblock processor and a hardware command decoder. The decoded command codeblocks are output to the spacecraft command/data subsystem. Virtual Channel 0 (VC-0) (hardware) commands are processed and output as critical controller (CRC) commands. Downlink telemetry is received from the spacecraft data subsystem as telemetry frames. The STM provides the following downlink coding options: the standard CCSDS (7-1/2) convolutional coding, ReedSolomon coding with interleave depths one and five, (15-1/6) convolutional coding, and Turbo coding with rates 1/3 and 1/6. The downlink symbol rates can be linearly ramped to match the G/T curve of the receiving station, providing up to a 1 dB increase in data return. Data rates range from 5 bits per second (bps) to 24 Mbps, with three modulation modes provided: modulated subcarrier (3 different frequencies provided), biphas-L modulated direct on carrier, and Offset QPSK. Also, the capability to generate one of four non-harmonically related telemetry beacon tones is provided, to allow for a simple spacecraft status monitoring scheme for cruise phases of missions. Three ranging modes are provided: standard turn around ranging, regenerative pseudo-noise (PN) ranging, and Differential One-way Ranging (DOR) tones. The regenerative ranging provides the capability of increasing the ground received ranging SNR by up to 30 dB. Two different avionics interfaces to the command/data subsystem's data bus are provided: a MIL STD 1553B bus or an industry standard PCI interface. Digital interfaces provide the capability to control antenna selection (e.g., switching between high gain and low gain antennas) and antenna pointing (for future steered Ka-band antennas).

Author

Modems; Transponders; Spacecraft Components; Spacecraft Communication; Spacecraft Equipment; Downlinking

20000063381 NASA Glenn Research Center, Cleveland, OH USA

Radiation Hardened, Modulator ASIC for High Data Rate Communications

McCallister, Ron; Putnam, Robert; Andro, Monty; Fujikawa, Gene; June 2000; In English; 18th, 10-14 Apr. 2000, Oakland, CA, USA

Contract(s)/Grant(s): NAS3-99096; RTOP 632-6E-51

Report No.(s): NASA/TM-2000-210045; E-12246; NAS 1.15:210045; No Copyright; Avail: CASI; [A03](#), Hardcopy

Satellite-based telecommunication services are challenged by the need to generate down-link power levels adequate to support high quality (BER approx. equals $10(\exp 12)$) links required for modem broadband data services. Bandwidth-efficient Nyquist signaling, using low values of excess bandwidth (α), can exhibit large peak-to-average-power ratio (PAPR) values. High PAPR values necessitate high-power amplifier (HPA) backoff greater than the PAPR, resulting in unacceptably low HPA efficiency. Given the high cost of on-board prime power, this inefficiency represents both an economical burden, and a constraint on the rates and quality of data services supportable from satellite platforms. Constant-envelope signals offer improved power-efficiency, but only by imposing a severe bandwidth-efficiency penalty. This paper describes a radiation-hardened modulator which can improve satellite-based broadband data services by combining the bandwidth-efficiency of low- α Nyquist signals with high power-efficiency (negligible HPA backoff).

Author

Telecommunication; Application Specific Integrated Circuits; Modulators; Power Efficiency

20000057505 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA USA

Optical Communication Transceiver For X2000; Second Delivery Program

Hemmati, H.; Lesh, J. R.; [2000]; In English; No Copyright; Avail: CASI; [A01](#), Hardcopy

Conceptual-design of a multi-functional optical instrument is underway for the X2000 - Second Delivery Program. The transceiver will perform both free-space optical- communication and science imaging by sharing a common 10-cm aperture telescope. A single focal-plane array (such as, APS-Active Pixel Sensor) in conjunction with a filter wheel will be used to perform the two functions. Targeted values for the transceiver's weight and power consumption are: 4 Kg, and 14 W. This transceiver would be capable of delivering greater than 10 Kbps to a 3.5-m diameter receiving station from the range of 2 AU during day-time.

Author

Free-Space Optical Communication; Imaging Techniques; Telescopes; Transmitter Receivers; Design Analysis

20000057332 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA USA

Pointing and Tracking Concepts for Deep Space Missions

Alexander, J. W.; Lee, S.; Chen, C.; [2000]; In English; No Copyright; Avail: CASI; [A03](#), Hardcopy

This paper summarizes part of a FY1998 effort on the design and development of an optical communications (Opcomm) subsystem for the Advanced Deep Space System Development (ADSSD) Project. This study was funded by the JPL X2000 program to develop an optical communications (Opcomm) subsystem for use in future planetary missions. The goal of this development effort was aimed at providing prototype hardware with the capability of performing uplink, downlink, and ranging functions from deep space distances. Such a system was envisioned to support future deep space missions in the Outer Planets/Solar Probe (OPSP) mission set such as the Pluto express and Europa orbiter by providing a significant enhancement of data return capability. A study effort was initiated to develop a flyable engineering model optical terminal to support the proposed Europa Orbiter mission - as either the prime telecom subsystem or for mission augmentation. The design concept was to extend the prototype lasercom terminal development effort currently conducted by JPL's Optical Communications Group. The subsystem would track the sun illuminated Earth at Europa and farther distances for pointing reference. During the course of the study, a number of challenging issues were found. These included thermo-mechanical distortion, straylight control, and pointing. This paper focuses on the pointing aspects required to locate and direct a laser beam from a spacecraft (S/C) near Jupiter to a receiving station on Earth.

Author

Equipment Specifications; Research and Development; Optical Communication; Aerospace Engineering; Systems Engineering

20000056608 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA USA

Overview of the Preliminary Design of the Optical Communication Demonstration and High-Rate Link Facility

Sandusky, John V.; Jeganathan, M.; Ortiz, G.; Biswas, A.; Lee, S.; Parker, G.; Liu, B.; Johnson, D.; DePew, J.; Lesh, J. R.; [2000]; In English; No Copyright; Avail: CASI; [A02](#), Hardcopy

This paper presents an overview of the preliminary design of both the flight and ground systems of the Optical Communication Demonstration and High-Rate Link Facility which will demonstrate optical communication from the International Space Station to ground after its deployment in October 2002. The overview of the preliminary design of the Flight System proceeds by contrasting it with the design of the laboratory-model unit, emphasizing key changes and the rationale behind the design choices. After presenting the preliminary design of the Ground System, the timetable for the construction and deployment of the flight and ground systems is outlined.

Author

Construction; Optical Communication; Research Facilities; Design Analysis

20000054687 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA USA

System Requirements for a Deep Space Optical Transceiver

Chen, C.; Alexander, J. W.; Hemmati, H.; Monacos, S.; Yan, T.; Lee, S.; Lesh, J. R.; Zingales, S.; [2000]; In English; Copyright; Avail: Other Sources

The functional requirements and design drivers for an Optical Communications subsystem are assessed based on the system requirements imposed by a proposed Europa Orbiter mission. Unlike near-Earth optical communications systems, deep space missions impose a unique set of requirements that drives the subsystem design. Significant challenges on laser efficiency, thermal control, pointing and tracking, stray/scatter light control, and subsystem mass/power need to be addressed for a successful subsystem implementation. The baseline design concept for a lasercom subsystem for the Europa orbiter mission employs a 30-cm diameter, diffraction-limited telescope, and a diode pumped solid state laser operating at 1.06 μ m to support downlink communications. The baseline pointing and tracking approach is to perform Earth Image tracking with occasional calibration using the Earth-moon or Earth-star images. At high phase angles when the Earth image does not provide sufficient brightness for high rate tracking, inertial sensors (accelerometers) measurements are used to propagate the knowledge of the optical boresight at a higher rate in between celestial reference updates. Additionally, uplink beacon tracking will be used to support pointing at short range and near solar opposition when Earth image alone does not provide sufficient signal power for tracking.

Author

Functional Design Specifications; Systems Engineering; Telecommunication; Optical Communication; Transmitter Receivers

20000033995 NASA Glenn Research Center, Cleveland, OH USA

Satellite Communications Using Commercial Protocols

Ivancic, William D.; Griner, James H.; Dimond, Robert; Frantz, Brian D.; Kachmar, Brian; Shell, Dan; February 2000; In English; 18th International Communication Satellite Systems, 10-14 Apr. 2000, Oakland, CA, USA

Contract(s)/Grant(s): RTOP 632-6E-51

Report No.(s): NASA/TM-2000-209796; E-12086; NAS 1.15:209796; AIAA Paper 2000-1185; No Copyright; Avail: CASI; [A03](#), Hardcopy

NASA Glenn Research Center has been working with industry, academia, and other government agencies in assessing commercial communications protocols for satellite and space-based applications. In addition, NASA Glenn has been developing and advocating new satellite-friendly modifications to existing communications protocol standards. This paper summarizes recent research into the applicability of various commercial standard protocols for use over satellite and space-based communications networks as well as expectations for future protocol development. It serves as a reference point from which the detailed work can be readily accessed. Areas that will be addressed include asynchronous-transfer-mode quality of service; completed and ongoing work of the Internet Engineering Task Force; data-link-layer protocol development for unidirectional link routing; and protocols for aeronautical applications, including mobile Internet protocol routing for wireless/mobile hosts and the aeronautical telecommunications network protocol.

Author

Satellite Communication; Protocol (Computers); Communication Networks; Asynchronous Transfer Mode; Product Development

Subject Terms

ABORT APPARATUS

Space-based Encoded Telemetry for Range Safety – 9

ADVANCED MICROWAVE SOUNDING UNIT

Integrated AMSU-A. Earth Observing System (EOS), Advanced Microwave Sounding Unit-A (AMSU-A): Engineering Telemetry Description – 11

AEROSPACE ENGINEERING

Pointing and Tracking Concepts for Deep Space Missions – 13

ANTENNA ARRAYS

Beam-Switch Transient Effects in the RF Path of the ICAPA Receive Phased Array Antenna – 5

APPLICATION SPECIFIC INTEGRATED CIRCUITS

Radiation Hardened, Modulator ASIC for High Data Rate Communications – 12

APPROXIMATION

Regular and chaotic dynamics of periodically amplified picosecond solitons – 8

ARCHITECTURE (COMPUTERS)

Near Earth Architectural Options for a Future Deep Space Optical Communications Network – 4

ASYNCHRONOUS TRANSFER MODE

ATM QoS Experiments Using TCP Applications: Performance of TCP/IP Over ATM in a Variety of Errored Links – 11

Satellite Communications Using Commercial Protocols – 14

ATTITUDE (INCLINATION)

Attenuation mechanism effect on filter shape in channelized dynamic spectral equalizers – 3

BANDWIDTH

Attenuation mechanism effect on filter shape in channelized dynamic spectral equalizers – 3

BEAM STEERING

Continuous Beam Steering From A Segmented Liquid Crystal Optical Phased Array – 7

BEAM SWITCHING

Beam-Switch Transient Effects in the RF Path of the ICAPA Receive Phased Array Antenna – 5

BEAMS (RADIATION)

First Experimental Demonstration of Full-Duplex Optical Communication on a Single Beam – 9

BIT ERROR RATE

Optimum divergence angle of a Gaussian beam wave in the presence of random jitter in free-space laser communication systems – 6

BRAGG GRATINGS

High-speed two-dimensional laser scanner based on Bragg gratings stored in photothermorefractive glass – 4

CALIBRATING

LOWCAL Ground Receiver: PMT Characterization Procedure and Results – 10

CHANNEL FLOW

Attenuation mechanism effect on filter shape in channelized dynamic spectral equalizers – 3

CHANNELS (DATA TRANSMISSION)

Optimum divergence angle of a Gaussian beam wave in the presence of random jitter in free-space laser communication systems – 6

CHAOS

Regular and chaotic dynamics of periodically amplified picosecond solitons – 8

CHIRP

Regular and chaotic dynamics of periodically amplified picosecond solitons – 8

CIRCUIT BOARDS

Design and implementation of a modulator-based free-space optical backplane for multiprocessor applications – 6

COMMUNICATION EQUIPMENT

Optical systems for free-space laser communications – 2

Simple technique to widen the passband of a free-space optics multiplexer and demultiplexer – 4

COMMUNICATION NETWORKS

Architectural Options for a Future Deep Space Optical Communications Network – 2

Near Earth Architectural Options for a Future Deep Space Optical Communications Network – 4

Satellite Communications Using Commercial Protocols – 14

COMMUNICATION SATELLITES

Optimum divergence angle of a Gaussian beam wave in the presence of random jitter in free-space laser communication systems – 6

COMPONENT RELIABILITY

Implementation of a 622 Mbps Digital Modem – 8

COMPUTER NETWORKS

Standard Message Definition - Statement of Need – 10

COMPUTERIZED SIMULATION

Continuous Beam Steering From A Segmented Liquid Crystal Optical Phased Array – 7

Three-Dimensional Simulation of Traveling-Wave Tube Cold-Test Characteristics Using CST MICROWAVE STUDIO – 4

CONSTRUCTION

Overview of the Preliminary Design of the Optical Communication Demonstration and High-Rate Link Facility – 13

CONTINUOUS RADIATION

Continuous Beam Steering From A Segmented Liquid Crystal Optical Phased Array – 7

DATA ACQUISITION

Standard Message Definition - Statement of Need – 10

DATA FLOW ANALYSIS

Implementation of a 622 Mbps Digital Modem – 8

DATA LINKS

Adding HDLC Framing to CCSDS Recommendations – 1

Optimum divergence angle of a Gaussian beam wave in the presence of random jitter in free-space laser communication systems – 6

DATA TRANSMISSION

Spatial phase information transmission through an optical fiber by coherence function synthesis – 6

Telemetry Networks – 11

Variable Delay Testing Using ONE – 8

DEEP SPACE

The Case for Deep Space Telecommunications Relay Stations – 2

DEMULTIPLEXING

Simple technique to widen the passband of a free-space optics multiplexer and demultiplexer – 4

DEPLOYMENT

TDRS-1 Going Strong at 20 – 2

DESIGN ANALYSIS

Optical Communication Transceiver For X2000; Second Delivery Program – 12

Overview of the Preliminary Design of the Optical Communication Demonstration and High-Rate Link Facility – 13

DIGITAL SYSTEMS

Space-based Encoded Telemetry for Range Safety – 9

DOWNLINKING

First Experimental Demonstration of Full-Duplex Optical Communication on a Single Beam – 9

The NASA Spacecraft Transponding Modem – 11

EARTH OBSERVING SYSTEM (EOS)

Integrated AMSU-A. Earth Observing System (EOS), Advanced Microwave Sounding Unit-A (AMSU-A): Engineering Telemetry Description – 11

EMITTERS

Infrared Communications for Small Spacecraft: From a Wireless Bus to Cluster Concepts – 10

EQUALIZERS (CIRCUITS)

Attenuation mechanism effect on filter shape in channelized dynamic spectral equalizers – 3

EQUIPMENT SPECIFICATIONS

Pointing and Tracking Concepts for Deep Space Missions – 13

ERROR ANALYSIS

Orbit Determination Error Analysis Results for the Triana Sun-Earth L2 Libration Point Mission – 3

EXTREMELY HIGH FREQUENCIES

Preliminary Results from NASA/GSFC Ka-Band High Rate Demonstration for Near-Earth Communications – 1

FERROELECTRIC MATERIALS

Analysis of light propagation in index-tunable photonic crystals – 6

FIBER OPTICS

Regular and chaotic dynamics of periodically amplified picosecond solitons – 8

Spatial phase information transmission through an optical fiber by coherence function synthesis – 6

FLIGHT OPERATIONS

High-Rate Communications Outage Recorder Operations for Optimal Payload and Science Telemetry Management On-board the International Space Station – 7

FOURIER TRANSFORMATION

Spatial phase information transmission through an optical fiber by coherence function synthesis – 6

FOUR-WAVE MIXING

Analysis of power-dependent phase-matched four-wave mixing in dispersion-managed transmission systems – 3

FREE-SPACE OPTICAL COMMUNICATION

Free Space Optical Communications System Pointer – 1

Optical Communication Transceiver For X2000; Second Delivery Program – 12

FREQUENCY DIVISION MULTIPLEXING

Implementation of a 622 Mbps Digital Modem – 8

FUNCTIONAL DESIGN SPECIFICATIONS

System Requirements for a Deep Space Optical Transceiver – 13

GRATINGS (SPECTRA)

Design and implementation of a modulator-based free-space optical backplane for multiprocessor applications – 6

GROUP VELOCITY

Analysis of light propagation in index-tunable photonic crystals – 6

HIGH SPEED

High-speed two-dimensional laser scanner based on Bragg gratings stored in photothermorefractive glass – 4

HOLOGRAPHY

Spatial phase information transmission through an optical fiber by coherence function synthesis – 6

IMAGING TECHNIQUES

Optical Communication Transceiver For X2000; Second Delivery Program – 12

INFRARED RADIATION

Infrared Communications for Small Spacecraft: From a Wireless Bus to Cluster Concepts – 10

INFRARED SPECTRA

High-speed two-dimensional laser scanner based on Bragg gratings stored in photothermorefractive glass – 4

INTERNATIONAL SPACE STATION

High-Rate Communications Outage Recorder Operations for Optimal Payload and Science Telemetry Management On-board the International Space Station – 7

INTERPLANETARY SPACECRAFT

Near Earth Architectural Options for a Future Deep Space Optical Communications Network – 4

KINEMATICS

Free Space Optical Communications System Pointer – 1

LARGE SPACE STRUCTURES

The Case for Deep Space Telecommunications Relay Stations – 2

LASER APPLICATIONS

High-speed two-dimensional laser scanner based on Bragg gratings stored in photothermorefractive glass – 4

Overview of Laser Activities at FOI Linköping, Sweden – 9

LASERS

First Experimental Demonstration of Full-Duplex Optical Communication on a Single Beam – 9

Overview of Laser Activities at FOI Linköping, Sweden – 9

LAUNCH VEHICLES

Space-based Encoded Telemetry for Range Safety – 9

LIGHT AMPLIFIERS

Optical-Fiber Amplifier Research – 10

LIGHT MODULATION

Design and implementation of a modulator-based free-space optical backplane for multiprocessor applications – 6

Regular and chaotic dynamics of periodically amplified picosecond solitons – 8

LIGHT TRANSMISSION

Analysis of light propagation in index-tunable photonic crystals – 6

Spatial phase information transmission through an optical fiber by coherence function synthesis – 6

LIQUID CRYSTALS

Attenuation mechanism effect on filter shape in channelized dynamic spectral equalizers – 3

Continuous Beam Steering From A Segmented Liquid Crystal Optical Phased Array – 7

LOW EARTH ORBITS

Orbit Determination Error Analysis Results for the Triana Sun-Earth L2 Libration Point Mission – 3

LOW NOISE

LOWCAL Ground Receiver: PMT Characterization Procedure and Results – 10

MESSAGES

Standard Message Definition - Statement of Need – 10

MICROWAVE SOUNDING

Integrated AMSU-A. Earth Observing System (EOS), Advanced Microwave Sounding Unit-A (AMSU-A): Engineering Telemetry Description – 11

MODEMS

Implementation of a 622 Mbps Digital Modem – 8

The NASA Spacecraft Transponding Modem – 11

MODULATION

Regular and chaotic dynamics of periodically amplified picosecond solitons – 8

MODULATORS

Radiation Hardened, Modulator ASIC for High Data Rate Communications – 12

MULTIPLEXING

High-speed two-dimensional laser scanner based on Bragg gratings stored in photothermorefractive glass – 4

Simple technique to widen the passband of a free-space optics multiplexer and demultiplexer – 4

MULTIPROCESSING (COMPUTERS)

Design and implementation of a modulator-based free-space optical backplane for multiprocessor applications – 6

NETWORKS

Analysis of power-dependent phase-matched four-wave mixing in dispersion-managed transmission systems – 3

Attenuation mechanism effect on filter shape in channelized dynamic spectral equalizers – 3

Variable Delay Testing Using ONE – 8

NONLINEAR OPTICS

Regular and chaotic dynamics of periodically amplified picosecond solitons – 8

OPTICAL COMMUNICATION

Analysis of power-dependent phase-matched four-wave mixing in dispersion-managed transmission systems – 3

Architectural Options for a Future Deep Space Optical Communications Network – 2

Attenuation mechanism effect on filter shape in channelized dynamic spectral equalizers – 3

Continuous Beam Steering From A Segmented Liquid Crystal Optical Phased Array – 7

Design and implementation of a modulator-based free-space optical backplane for multiprocessor applications – 6

First Experimental Demonstration of Full-Duplex Optical Communication on a Single Beam – 9

High-speed two-dimensional laser scanner based on Bragg gratings stored in photothermorefractive glass – 4

Infrared Communications for Small Spacecraft: From a Wireless Bus to Cluster Concepts – 10

LOWCAL Ground Receiver: PMT Characterization Procedure and Results – 10

Near Earth Architectural Options for a Future Deep Space Optical Communications Network – 4

Optical systems for free-space laser communications – 2

Optical-Fiber Amplifier Research – 10

Optimum divergence angle of a Gaussian beam wave in the presence of random jitter in free-space laser communication systems – 6

Overview of the MARS Laser Communications Demonstration Project – 5

Overview of the Preliminary Design of the Optical Communication Demonstration and High-Rate Link Facility – 13

Pointing and Tracking Concepts for Deep Space Missions – 13

Regular and chaotic dynamics of periodically amplified picosecond solitons – 8

Simple technique to widen the passband of a free-space optics multiplexer and demultiplexer – 4

Spatial phase information transmission through an optical fiber by coherence function synthesis – 6

System Requirements for a Deep Space Optical Transceiver – 13

OPTICAL COMPUTERS

Design and implementation of a modulator-based free-space optical backplane for multiprocessor applications – 6

OPTICAL DATA PROCESSING

Design and implementation of a modulator-based free-space optical backplane for multiprocessor applications – 6

OPTICAL EQUIPMENT

Optical systems for free-space laser communications – 2

OPTICAL FIBERS

Analysis of power-dependent phase-matched four-wave mixing in dispersion-managed transmission systems – 3

Attenuation mechanism effect on filter shape in channelized dynamic spectral equalizers – 3

Regular and chaotic dynamics of periodically amplified picosecond solitons – 8

Spatial phase information transmission through an optical fiber by coherence function synthesis – 6

OPTICAL INTERCONNECTS

Design and implementation of a modulator-based free-space optical backplane for multiprocessor applications – 6

OPTICAL SCANNERS

High-speed two-dimensional laser scanner based on Bragg gratings stored in photothermorefractive glass – 4

OPTICAL TRANSFER FUNCTION

Simple technique to widen the passband of a free-space optics multiplexer and demultiplexer – 4

OPTICAL WAVEGUIDES

Simple technique to widen the passband of a free-space optics multiplexer and demultiplexer – 4

OPTIMIZATION

Optimum divergence angle of a Gaussian beam wave in the presence of random jitter in free-space laser communication systems – 6

ORBIT DETERMINATION

Orbit Determination Error Analysis Results for the Triana Sun-Earth L2 Libration Point Mission – 3

ORBITS

Variable Delay Testing Using ONE – 8

PAYLOAD INTEGRATION

High-Rate Communications Outage Recorder Operations for Optimal Payload and Science Telemetry Management Onboard the International Space Station – 7

PERTURBATION THEORY

Regular and chaotic dynamics of periodically amplified picosecond solitons – 8

PHASE COHERENCE

Spatial phase information transmission through an optical fiber by coherence function synthesis – 6

PHASED ARRAYS

Beam-Switch Transient Effects in the RF Path of the ICAPA Receive Phased Array Antenna – 5

Continuous Beam Steering From A Segmented Liquid Crystal Optical Phased Array – 7

PHOTONICS

Overview of Laser Activities at FOI Linköping, Sweden – 9

POWER EFFICIENCY

Radiation Hardened, Modulator ASIC for High Data Rate Communications – 12

PRODUCT DEVELOPMENT

Satellite Communications Using Commercial Protocols – 14

PROTOCOL (COMPUTERS)

ATM QoS Experiments Using TCP Applications: Performance of TCP/IP Over ATM in a Variety of Errored Links – 11

Satellite Communications Using Commercial Protocols – 14

QUALITY CONTROL

ATM QoS Experiments Using TCP Applications: Performance of TCP/IP Over ATM in a Variety of Errored Links – 11

RADIO TELEMETRY

High-Rate Communications Outage Recorder Operations for Optimal Payload and Science Telemetry Management Onboard the International Space Station – 7

RANGE AND RANGE RATE TRACKING

Orbit Determination Error Analysis Results for the Triana Sun-Earth L2 Libration Point Mission – 3

RANGE SAFETY

Space-Based Encoded Telemetry for Range Safety – 7

Space-based Encoded Telemetry for Range Safety – 9

RECEIVERS

Optical systems for free-space laser communications – 2

RECORDING INSTRUMENTS

High-Rate Communications Outage Recorder Operations for Optimal Payload and Science Telemetry Management On-board the International Space Station – 7

REFRACTIVITY

Analysis of light propagation in index-tunable photonic crystals – 6

RELAY SATELLITES

The Case for Deep Space Telecommunications Relay Stations – 2

REMOTE SENSING

Overview of Laser Activities at FOI Linköping, Sweden – 9

RESEARCH AND DEVELOPMENT

Pointing and Tracking Concepts for Deep Space Missions – 13

RESEARCH FACILITIES

Overview of the Preliminary Design of the Optical Communication Demonstration and High-Rate Link Facility – 13

SAFETY MANAGEMENT

Space-Based Encoded Telemetry for Range Safety – 7

SATELLITE COMMUNICATION

Optical-Fiber Amplifier Research – 10

Preliminary Results from NASA/GSFC Ka-Band High Rate Demonstration for Near-Earth Communications – 1

Satellite Communications Using Commercial Protocols – 14

Variable Delay Testing Using ONE – 8

SATELLITE NETWORKS

Space-Based Encoded Telemetry for Range Safety – 7

TDRS-1 Going Strong at 20 – 2

SATELLITE TRANSMISSION

TDRS-1 Going Strong at 20 – 2

SCANNERS

High-speed two-dimensional laser scanner based on Bragg gratings stored in photothermorefractive glass – 4

SCATTERING

Regular and chaotic dynamics of periodically amplified picosecond solitons – 8

SCHROEDINGER EQUATION

Regular and chaotic dynamics of periodically amplified picosecond solitons – 8

SIGNAL TO NOISE RATIOS

Space-Based Encoded Telemetry for Range Safety – 7

SIMULATION

Overview of Laser Activities at FOI Linköping, Sweden – 9

SOLAR SYSTEM

Overview of the MARS Laser Communications Demonstration Project – 5

SOLITARY WAVES

Regular and chaotic dynamics of periodically amplified picosecond solitons – 8

SPACE COMMUNICATION

Adding HDLC Framing to CCSDS Recommendations – 1

Architectural Options for a Future Deep Space Optical Communications Network – 2

Implementation of a 622 Mbps Digital Modem – 8

SPACE MISSIONS

The Case for Deep Space Telecommunications Relay Stations – 2

SPACE SHUTTLES

Space-based Encoded Telemetry for Range Safety – 9

SPACECRAFT COMMUNICATION

Near Earth Architectural Options for a Future Deep Space Optical Communications Network – 4

TDRS-1 Going Strong at 20 – 2

The NASA Spacecraft Transponding Modem – 11

SPACECRAFT COMPONENTS

The NASA Spacecraft Transponding Modem – 11

SPACECRAFT EQUIPMENT

The NASA Spacecraft Transponding Modem – 11

SPACECRAFT STRUCTURES

Infrared Communications for Small Spacecraft: From a Wireless Bus to Cluster Concepts – 10

SPACE-TIME FUNCTIONS

Spatial phase information transmission through an optical fiber by coherence function synthesis – 6

SPREAD SPECTRUM TRANSMISSION

Space-based Encoded Telemetry for Range Safety – 9

SWITCHES

Analysis of light propagation in index-tunable photonic crystals – 6

SYSTEMS ENGINEERING

High-Rate Communications Outage Recorder Operations for Optimal Payload and Science Telemetry Management On-board the International Space Station – 7

Pointing and Tracking Concepts for Deep Space Missions – 13

System Requirements for a Deep Space Optical Transceiver – 13

TDR SATELLITES

Preliminary Results from NASA/GSFC Ka-Band High Rate Demonstration for Near-Earth Communications – 1

TDRS-1 Going Strong at 20 – 2

TELECOMMUNICATION

Optimum divergence angle of a Gaussian beam wave in the presence of random jitter in free-space laser communication systems – 6

Radiation Hardened, Modulator ASIC for High Data Rate Communications – 12

Space-Based Encoded Telemetry for Range Safety – 7

System Requirements for a Deep Space Optical Transceiver – 13

The Case for Deep Space Telecommunications Relay Stations – 2

TELEMETRY

Integrated AMSU-A. Earth Observing System (EOS), Advanced Microwave Sounding Unit-A (AMSU-A): Engineering Telemetry Description – 11

Space-Based Encoded Telemetry for Range Safety – 7

Space-based Encoded Telemetry for Range Safety – 9

Telemetry Networks – 11

TELESCOPES

Optical Communication Transceiver For X2000; Second Delivery Program – 12

Optical systems for free-space laser communications – 2

THREE DIMENSIONAL MODELS

Three-Dimensional Simulation of Traveling-Wave Tube Cold-Test Characteristics Using CST MICROWAVE STUDIO – 4

TIME DIVISION MULTIPLEXING

Spatial phase information transmission through an optical fiber by coherence function synthesis – 6

TRANSFER FUNCTIONS

Simple technique to widen the passband of a free-space optics multiplexer and demultiplexer – 4

TRANSMISSION LINES

Analysis of power-dependent phase-matched four-wave mixing in dispersion-managed transmission systems – 3

TRANSMITTER RECEIVERS

Optical Communication Transceiver For X2000; Second Delivery Program – 12

System Requirements for a Deep Space Optical Transceiver – 13

TRANSPONDERS

The NASA Spacecraft Transponding Modem – 11

TUNING

Analysis of light propagation in index-tunable photonic crystals – 6

VIBRATION

Optimum divergence angle of a Gaussian beam wave in the presence of random jitter in free-space laser communication systems – 6

VISIBLE SPECTRUM

High-speed two-dimensional laser scanner based on Bragg gratings stored in photothermorefractive glass – [4](#)

WAVE DIFFRACTION

High-speed two-dimensional laser scanner based on Bragg gratings stored in photothermorefractive glass – [4](#)

WAVE PROPAGATION

Three-Dimensional Simulation of Traveling-Wave Tube Cold-Test Characteristics Using CST MICROWAVE STUDIO – [4](#)

WAVEGUIDE FILTERS

Simple technique to widen the passband of a free-space optics multiplexer and demultiplexer – [4](#)

WAVELENGTH DIVISION MULTIPLEXING

Analysis of power-dependent phase-matched four-wave mixing in dispersion-managed transmission systems – [3](#)

Attenuation mechanism effect on filter shape in channelized dynamic spectral equalizers – [3](#)

Simple technique to widen the passband of a free-space optics multiplexer and demultiplexer – [4](#)

WIDE AREA NETWORKS

ATM QoS Experiments Using TCP Applications: Performance of TCP/IP Over ATM in a Variety of Errored Links – [11](#)

Corporate Sources

Aerojet-General Corp.

Integrated AMSU-A. Earth Observing System (EOS), Advanced Microwave Sounding Unit-A (AMSU-A): Engineering Telemetry Description – [11](#)

Computer Sciences Corp.

Adding HDLC Framing to CCSDS Recommendations – [1](#)

Florida Inst. of Tech.

Space-Based Encoded Telemetry for Range Safety – [7](#)

Space-based Encoded Telemetry for Range Safety – [9](#)

Jet Propulsion Lab., California Inst. of Tech.

Architectural Options for a Future Deep Space Optical Communications Network – [2](#)

Optical Communication Transceiver For X2000; Second Delivery Program – [12](#)

Overview of the Preliminary Design of the Optical Communication Demonstration and High-Rate Link Facility – [13](#)

Pointing and Tracking Concepts for Deep Space Missions – [13](#)

System Requirements for a Deep Space Optical Transceiver – [13](#)

The NASA Spacecraft Transponding Modem – [11](#)

NASA Glenn Research Center

ATM QoS Experiments Using TCP Applications: Performance of TCP/IP Over ATM in a Variety of Errored Links – [11](#)

Beam-Switch Transient Effects in the RF Path of the ICAPA Receive Phased Array Antenna – [5](#)

Continuous Beam Steering From A Segmented Liquid Crystal Optical Phased Array – [7](#)

Implementation of a 622 Mbps Digital Modem – [8](#)

Radiation Hardened, Modulator ASIC for High Data Rate Communications – [12](#)

Satellite Communications Using Commercial Protocols – [14](#)

Three-Dimensional Simulation of Traveling-Wave Tube Cold-Test Characteristics Using CST MICROWAVE STUDIO – [4](#)

Variable Delay Testing Using ONE – [8](#)

NASA Goddard Space Flight Center

Infrared Communications for Small Spacecraft: From a Wireless Bus to Cluster Concepts – [10](#)

Near Earth Architectural Options for a Future Deep Space Optical Communications Network – [4](#)

Orbit Determination Error Analysis Results for the Triana Sun-Earth L2 Libration Point Mission – [3](#)

Overview of the MARS Laser Communications Demonstration Project – [5](#)

Preliminary Results from NASA/GSFC Ka-Band High Rate Demonstration for Near-Earth Communications – [1](#)

TDRS-1 Going Strong at 20 – [2](#)

NASA Marshall Space Flight Center

High-Rate Communications Outage Recorder Operations for Optimal Payload and Science Telemetry Management On-board the International Space Station – [7](#)

National Space Development Agency

Optical-Fiber Amplifier Research – [10](#)

Naval Air Warfare Center

Standard Message Definition - Statement of Need – [10](#)

Telemetry Networks – [11](#)

New Mexico State Univ.

First Experimental Demonstration of Full-Duplex Optical Communication on a Single Beam – [9](#)

LOWCAL Ground Receiver: PMT Characterization Procedure and Results – [10](#)

Ross-Hime Designs, Inc.

Free Space Optical Communications System Pointer – [1](#)

Swedish Defence Research Establishment

Overview of Laser Activities at FOI Linköping, Sweden – [9](#)

University of South Florida

The Case for Deep Space Telecommunications Relay Stations – [2](#)

Document Authors

Alexander, J. W.

Pointing and Tracking Concepts for Deep Space Missions – [13](#)

System Requirements for a Deep Space Optical Transceiver – [13](#)

Andro, Monty

Radiation Hardened, Modulator ASIC for High Data Rate Communications – [12](#)

Arain, Muzammil A.

High-speed two-dimensional laser scanner based on Bragg gratings stored in photothermorefractive glass – [4](#)

Araki, Tomohiro

Optical-Fiber Amplifier Research – [10](#)

Ayliffe, Michael H.

Design and implementation of a modulator-based free-space optical backplane for multiprocessor applications – [6](#)

Benjamin, T.

Architectural Options for a Future Deep Space Optical Communications Network – [2](#)

Berner, Jeff B.

The NASA Spacecraft Transponding Modem – [11](#)

Bernier, Eric

Design and implementation of a modulator-based free-space optical backplane for multiprocessor applications – [6](#)

Biswas, A.

Overview of the Preliminary Design of the Optical Communication Demonstration and High-Rate Link Facility – [13](#)

Biswas, Abhijit

Overview of the MARS Laser Communications Demonstration Project – [5](#)

Bizon, Thomas P.

Implementation of a 622 Mbps Digital Modem – [8](#)

Bondurant, Roy S.

Overview of the MARS Laser Communications Demonstration Project – [5](#)

Boone, Bradley G.

Infrared Communications for Small Spacecraft: From a Wireless Bus to Cluster Concepts – [10](#)

Boroson, Don M.

Overview of the MARS Laser Communications Demonstration Project – [5](#)

Bos, Philip J.

Continuous Beam Steering From A Segmented Liquid Crystal Optical Phased Array – [7](#)

Bundick, Steven N.

Preliminary Results from NASA/GSFC Ka-Band High Rate Demonstration for Near-Earth Communications – [1](#)

Burnside, Jamie W.

Overview of the MARS Laser Communications Demonstration Project – [5](#)

Calderon, M.

Integrated AMSU-A. Earth Observing System (EOS), Advanced Microwave Sounding Unit-A (AMSU-A): Engineering Telemetry Description – [11](#)

Chandler, Charles W.

The Case for Deep Space Telecommunications Relay Stations – [2](#)

Chassagne, Bruno

Simple technique to widen the passband of a free-space optics multiplexer and demultiplexer – [4](#)

Chen, C.

Pointing and Tracking Concepts for Deep Space Missions – [13](#)

System Requirements for a Deep Space Optical Transceiver – [13](#)

Chevalier, Christine T.

Three-Dimensional Simulation of Traveling-Wave Tube Cold-Test Characteristics Using CST MICROWAVE STUDIO – [4](#)

Crisciuolo, Ed

Adding HDLC Framing to CCSDS Recommendations – [1](#)

Cross, Andrew W.

Three-Dimensional Simulation of Traveling-Wave Tube Cold-Test Characteristics Using CST MICROWAVE STUDIO – [4](#)

Darrin, M. Ann G.

Infrared Communications for Small Spacecraft: From a Wireless Bus to Cluster Concepts – [10](#)

Day, John H.

Infrared Communications for Small Spacecraft: From a Wireless Bus to Cluster Concepts – [10](#)

DePew, J.

Overview of the Preliminary Design of the Optical Communication Demonstration and High-Rate Link Facility – [13](#)

Dimond, Robert

Satellite Communications Using Commercial Protocols – [14](#)

Edward, Bernard L.

Overview of the MARS Laser Communications Demonstration Project – [5](#)

Edwards, B. L.

Architectural Options for a Future Deep Space Optical Communications Network – [2](#)

Near Earth Architectural Options for a Future Deep Space Optical Communications Network – [4](#)

Fitzgerald, R. J.

Architectural Options for a Future Deep Space Optical Communications Network – [2](#)

Near Earth Architectural Options for a Future Deep Space Optical Communications Network – [4](#)

Frantz, Brian D.

ATM QoS Experiments Using TCP Applications: Performance of TCP/IP Over ATM in a Variety of Errored Links – [11](#)

Satellite Communications Using Commercial Protocols – [14](#)

Fujikawa, Gene

Radiation Hardened, Modulator ASIC for High Data Rate Communications – [12](#)

Fukushima, Hiroshi

Analysis of light propagation in index-tunable photonic crystals – [6](#)

Gao, Shiming

Analysis of power-dependent phase-matched four-wave mixing in dispersion-managed transmission systems – [3](#)

Garrett, Christopher David

First Experimental Demonstration of Full-Duplex Optical Communication on a Single Beam – [9](#)

Gioannini, Bryan

Preliminary Results from NASA/GSFC Ka-Band High Rate Demonstration for Near-Earth Communications – [1](#)

Griner, James H.

Satellite Communications Using Commercial Protocols – [14](#)

Hemmati, H.

Optical Communication Transceiver For X2000; Second Delivery Program – [12](#)

Optical systems for free-space laser communications – [2](#)

System Requirements for a Deep Space Optical Transceiver – [13](#)

Herrmann, Kimberly A.

Three-Dimensional Simulation of Traveling-Wave Tube Cold-Test Characteristics Using CST MICROWAVE STUDIO – [4](#)

Hizanidis, Kyriakos

Regular and chaotic dynamics of periodically amplified picosecond solitons – [8](#)

- Hogie, Keith**
Adding HDLC Framing to CCSDS Recommendations – 1
- Ishac, Joseph**
Variable Delay Testing Using ONE – 8
- Ivancic, William D.**
ATM QoS Experiments Using TCP Applications: Performance of TCP/IP Over ATM in a Variety of Errored Links – 11
Satellite Communications Using Commercial Protocols – 14
- Jeganathan, M.**
Overview of the Preliminary Design of the Optical Communication Demonstration and High-Rate Link Facility – 13
- Jin, Guofan**
Analysis of power-dependent phase-matched four-wave mixing in dispersion-managed transmission systems – 3
- Johnson, D.**
Overview of the Preliminary Design of the Optical Communication Demonstration and High-Rate Link Facility – 13
- Jones, Sid**
Standard Message Definition - Statement of Need – 10
Telemetry Networks – 11
- Jono, Takashi**
Optimum divergence angle of a Gaussian beam wave in the presence of random jitter in free-space laser communication systems – 6
- Kachmar, Brian**
Satellite Communications Using Commercial Protocols – 14
- Kannari, Fumihiko**
Spatial phase information transmission through an optical fiber by coherence function synthesis – 6
- Kayalar, Selahattin**
The NASA Spacecraft Transponding Modem – 11
- Khatiri, Farzana I.**
Overview of the MARS Laser Communications Demonstration Project – 5
- Khatiri, F.**
Architectural Options for a Future Deep Space Optical Communications Network – 2
- Kifle, Muli**
Implementation of a 622 Mbps Digital Modem – 8
- Kirk, Andrew G.**
Design and implementation of a modulator-based free-space optical backplane for multiprocessor applications – 6
- Kominis, Yannis**
Regular and chaotic dynamics of periodically amplified picosecond solitons – 8
- Kory, Carol L.**
Three-Dimensional Simulation of Traveling-Wave Tube Cold-Test Characteristics Using CST MICROWAVE STUDIO – 4
- Kozaitis, Sam**
Space-based Encoded Telemetry for Range Safety – 9
- Kozaitis, Samuel P.**
Space-Based Encoded Telemetry for Range Safety – 7
- Lacroix, Frederic K.**
Design and implementation of a modulator-based free-space optical backplane for multiprocessor applications – 6
- Lee, S.**
Overview of the Preliminary Design of the Optical Communication Demonstration and High-Rate Link Facility – 13
Pointing and Tracking Concepts for Deep Space Missions – 13
System Requirements for a Deep Space Optical Transceiver – 13
- Lesh, J. R.**
Optical Communication Transceiver For X2000; Second Delivery Program – 12
Overview of the Preliminary Design of the Optical Communication Demonstration and High-Rate Link Facility – 13
System Requirements for a Deep Space Optical Transceiver – 13
- Liebrecht, P. E.**
Architectural Options for a Future Deep Space Optical Communications Network – 2
Near Earth Architectural Options for a Future Deep Space Optical Communications Network – 4
- Liu, B.**
Overview of the Preliminary Design of the Optical Communication Demonstration and High-Rate Link Facility – 13
- Luers, Philip J.**
Infrared Communications for Small Spacecraft: From a Wireless Bus to Cluster Concepts – 10
- MacCannell, John, Alexander**
LOWCAL Ground Receiver: PMT Characterization Procedure and Results – 10
- Marom, Dan M.**
Attenuation mechanism effect on filter shape in channelized dynamic spectral equalizers – 3
- Marr, G.**
Orbit Determination Error Analysis Results for the Triana Sun-Earth L2 Libration Point Mission – 3
- McCallister, Ron**
Radiation Hardened, Modulator ASIC for High Data Rate Communications – 12
- McElyea, Richard M.**
High-Rate Communications Outage Recorder Operations for Optimal Payload and Science Telemetry Management On-board the International Space Station – 7
- Miller, David T.**
Preliminary Results from NASA/GSFC Ka-Band High Rate Demonstration for Near-Earth Communications – 1
- Miranda, Felix A.**
The Case for Deep Space Telecommunications Relay Stations – 2
- Miranda, Felix**
Continuous Beam Steering From A Segmented Liquid Crystal Optical Phased Array – 7
- Monacos, S.**
System Requirements for a Deep Space Optical Transceiver – 13
- Mortensen, Dale J.**
Implementation of a 622 Mbps Digital Modem – 8
- Nakagawa, Keizo**
Optimum divergence angle of a Gaussian beam wave in the presence of random jitter in free-space laser communication systems – 6
- Nguyen, Hung**
Continuous Beam Steering From A Segmented Liquid Crystal Optical Phased Array – 7
- Nguyen, Nam T.**
Implementation of a 622 Mbps Digital Modem – 8
- Oh, Sang-Hyun**
Attenuation mechanism effect on filter shape in channelized dynamic spectral equalizers – 3
- Ortiz, G.**
Overview of the Preliminary Design of the Optical Communication Demonstration and High-Rate Link Facility – 13
- Parise, Ron**
Adding HDLC Framing to CCSDS Recommendations – 1
- Parker, G.**
Overview of the Preliminary Design of the Optical Communication Demonstration and High-Rate Link Facility – 13
- Parvin, B.**
Architectural Options for a Future Deep Space Optical Communications Network – 2
- Parvin, Ben A.**
Overview of the MARS Laser Communications Demonstration Project – 5
- Perret, Jonathan D.**
The NASA Spacecraft Transponding Modem – 11

- Pillsbury, Alan D.**
Overview of the MARS Laser Communications Demonstration Project – 5
- Plant, David V.**
Design and implementation of a modulator-based free-space optical backplane for multiprocessor applications – 6
- Pouch, John**
Continuous Beam Steering From A Segmented Liquid Crystal Optical Phased Array – 7
- Putnam, Robert**
Radiation Hardened, Modulator ASIC for High Data Rate Communications – 12
- Ravelomanana, Vlady**
Simple technique to widen the passband of a free-space optics multiplexer and demultiplexer – 4
- Riza, Nabeel A.**
High-speed two-dimensional laser scanner based on Bragg gratings stored in photothermorefractive glass – 4
- Robertson, Brian**
Design and implementation of a modulator-based free-space optical backplane for multiprocessor applications – 6
- Rolston, David R.**
Design and implementation of a modulator-based free-space optical backplane for multiprocessor applications – 6
- Rosheim, Mark E.**
Free Space Optical Communications System Pointer – 1
- Sands, O. Scott**
Beam-Switch Transient Effects in the RF Path of the ICAPA Receive Phased Array Antenna – 5
- Sandusky, John V.**
Overview of the Preliminary Design of the Optical Communication Demonstration and High-Rate Link Facility – 13
- Santana, Samuel**
Three-Dimensional Simulation of Traveling-Wave Tube Cold-Test Characteristics Using CST MICROWAVE STUDIO – 4
- Sauter, Gerald F.**
Free Space Optical Communications System Pointer – 1
- Schneider, Wolfger**
Infrared Communications for Small Spacecraft: From a Wireless Bus to Cluster Concepts – 10
- Scozzafava, J.**
Architectural Options for a Future Deep Space Optical Communications Network – 2
- Scozzafava, Joseph J.**
Overview of the MARS Laser Communications Demonstration Project – 5
- Sharma, J.**
Architectural Options for a Future Deep Space Optical Communications Network – 2
- Shay, Thomas**
First Experimental Demonstration of Full-Duplex Optical Communication on a Single Beam – 9
- Shell, Dan**
Satellite Communications Using Commercial Protocols – 14
- Shell, Michael T.**
High-Rate Communications Outage Recorder Operations for Optimal Payload and Science Telemetry Management Onboard the International Space Station – 7
- Steinvall, O.**
Overview of Laser Activities at FOI Linköping, Sweden – 9
- Szymanski, Ted H.**
Design and implementation of a modulator-based free-space optical backplane for multiprocessor applications – 6
- Teramura, Yuichi**
Spatial phase information transmission through an optical fiber by coherence function synthesis – 6
- Titus, Charles M.**
Continuous Beam Steering From A Segmented Liquid Crystal Optical Phased Array – 7
- Tooley, Frank A. P.**
Design and implementation of a modulator-based free-space optical backplane for multiprocessor applications – 6
- Townes, Stephen A.**
Overview of the MARS Laser Communications Demonstration Project – 5
- Toyoshima, Morio**
Optimum divergence angle of a Gaussian beam wave in the presence of random jitter in free-space laser communication systems – 6
- Tran, Quang K.**
Implementation of a 622 Mbps Digital Modem – 8
- Vranesic, Zvonko G.**
Design and implementation of a modulator-based free-space optical backplane for multiprocessor applications – 6
- Webb, Suzanne C.**
Infrared Communications for Small Spacecraft: From a Wireless Bus to Cluster Concepts – 10
- Wilson, Jeffrey D.**
Three-Dimensional Simulation of Traveling-Wave Tube Cold-Test Characteristics Using CST MICROWAVE STUDIO – 4
- Wong, Yen**
Preliminary Results from NASA/GSFC Ka-Band High Rate Demonstration for Near-Earth Communications – 1
- Xiong, Sibe**
Analysis of light propagation in index-tunable photonic crystals – 6
- Yamamoto, Akio**
Optimum divergence angle of a Gaussian beam wave in the presence of random jitter in free-space laser communication systems – 6
- Yan, T.**
System Requirements for a Deep Space Optical Transceiver – 13
- Yang, Changxi**
Analysis of power-dependent phase-matched four-wave mixing in dispersion-managed transmission systems – 3
- Yaqoob, Zahid**
High-speed two-dimensional laser scanner based on Bragg gratings stored in photothermorefractive glass – 4
- Zingales, S.**
System Requirements for a Deep Space Optical Transceiver – 13